Geohydrology of the Bethpage-Hicksville-Levittown Area, Long Island, New York

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations
Report 88-4135

Prepared in cooperation with the
NASSAU COUNTY DEPARTMENT OF HEALTH

GEOHYDROLOGY OF THE BETHPAGE-HICKSVILLE-LEVITTOWN AREA, LONG ISLAND, NEW YORK

by Douglas A. Smolensky and Steven M. Feldman

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations
Report 88-4135

H_2O QUALITY

NOT AVAILABLE YET

MODELING

VALARIE EGAN

Prepared in cooperation with

NASSAU COUNTY DEPARTMENT OF HEALTH

Syosset, New York
1990

DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to:

U.S. Geological Survey
5 Aerial Way
Syosset, NY 11791

938-8830

Copies of this report may be purchased from:

Books and Open-File Reports Section
Federal Center, Bldg. 41
U.S. Geological Survey
Box 25425
Denver, CO 80225
(303) 236-7476

CONTENTS

ILLUSTRATIONS

HKR 001 1812

ILLUSTRATIONS (Continued)

PLATE

(in pocket)

TABLE

CONVERSION FACTORS AND ABBREVIATIONS

For the convenience of readers who may prefer to use metric (International System) units rather than the inch-pound units used in this report, values may be converted by using the following factors:

Multiply inch-pound unit	By	To obtain metric unit
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Volume	
gallon (gal)	3.785	liter (L)
	Flow	
foot per day (ft/d)	0.3048	meter per day (m/d)
million gallons per day (Mgal/d)	0.04381	cubic meters per second (m^3/s)

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "sea level datum of 1929."

GEOHYDROLOGY OF THE BETHPAGE-HICKSVILLE-LEVITTOWN AREA, LONG ISLAND, NEW YORK

by Douglas A. Smolensky and Steven M. Feldman

ABSTRACT

A study of ground-water levels and flow in east-central Nassau County, N.Y., began in October 1985. The 11.4 square-mile area encompasses parts of Bethpage, Hicksville, Levittown, Plainview, Plainedge, and Farmingdale.

Approximately 1,200 feet of unconsolidated Cretaceous deposits and 50 to 100 feet of Pleistocene deposits overlie bedrock throughout the area. The unconsolidated deposits consist mostly of sand, gravel, silt, and clay and have good water-transmitting properties except where clay forms continuous layers that can impede ground-water flow.

The area is mostly residential and industrial. Pumpage for public supply exceeds 10 million gallons per day, most of which eventually discharges from the ground-water system to tidewater as sewage outflow. Industrial pumpage during summer exceeds 10 million gallons per day, but most of the water is returned to the system through recharge basins. Ground-water levels in this area fluctuate seasonally in response to natural recharge, pumping, and use of recharge basins.

INTRODUCTION

Ground water is the sole source of fresh water for Nassau and Suffolk Counties on Long Island (fig. 1); therefore, conservation and protection of this resource is a vital concern for local water managers and planners. Proper management requires a thorough knowledge of the hydrologic and geologic environment, directions and rates of ground-water movement, and the long- and short-term effects of natural and human-induced stresses on the ground-water system.

The demand for ground water in east-central Nassau County, a highly developed area that includes parts of Bethpage, Hicksville, Levittown, Plainview, Plainedge, and Farmingdale (fig. 2), has placed an increasing stress upon the underlying aquifers that is reflected as changes in regional and local ground-water flow patterns. Also, large-scale industrial and residential development has increased the potential for contamination of the ground-water system. Ground water in some areas has already been contaminated, and the upper glacial aquifer is no longer a suitable source for public supply in these areas. Isolated occurrences of contamination of the underlying Magothy aquifer also have been documented.

The area studied is an 11.4-square-mile (mi^2) rectangle (7,296 acres) that measures 3.8 miles from north to south and 3.0 miles from east to west. The northern and southeastern sections are in the Town of Oyster Bay and include parts of Hicksville, Plainview, Bethpage, Plainedge, and Farmingdale; the southwestern corner is in the Town of Hempstead and includes part of Levittown (fig. 2). The area is herein referred to as the Bethpage-Hicksville-Levittown area for brevity.

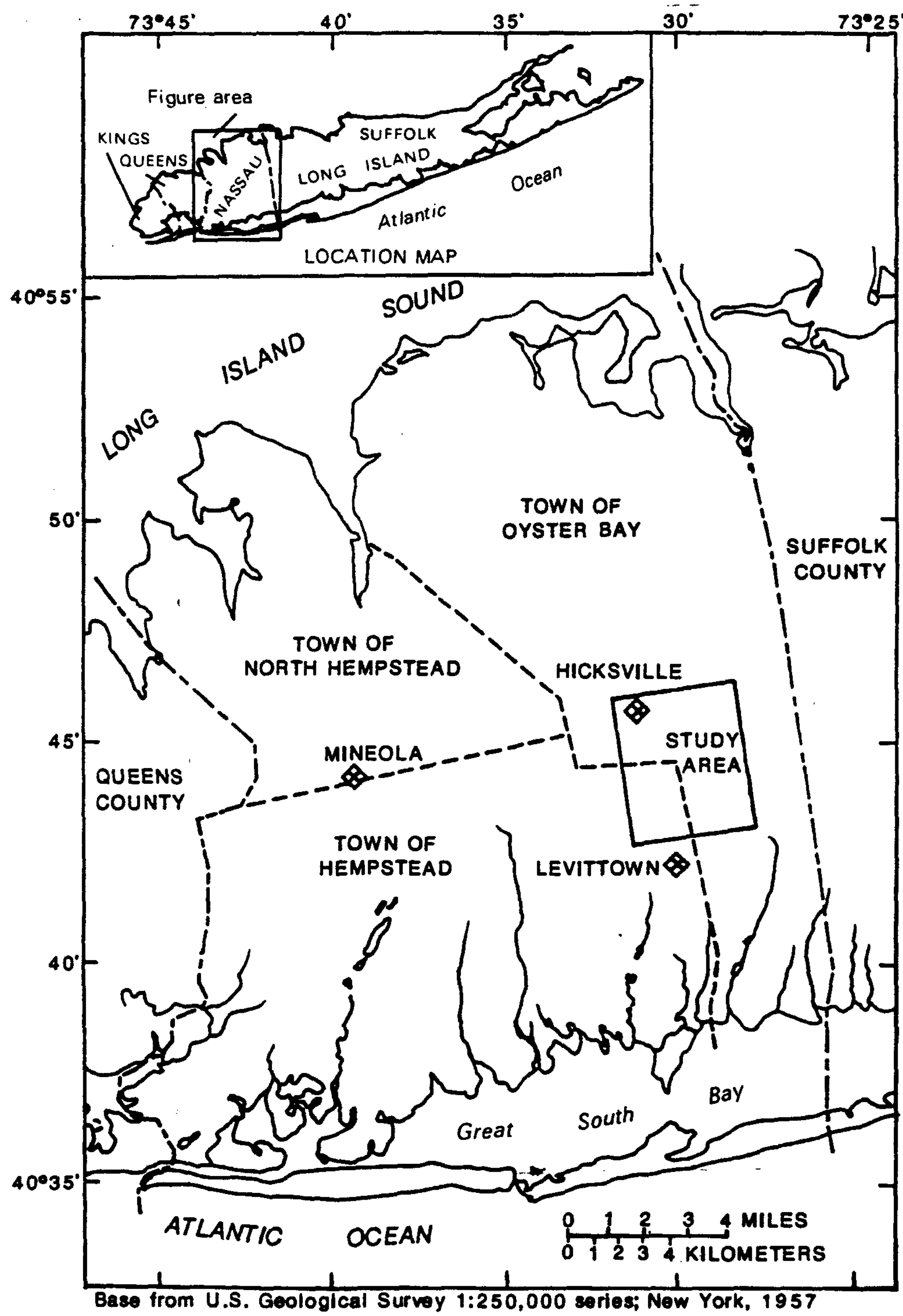


Figure 1. Location and major geographic features of study area.

HKR 001 1816

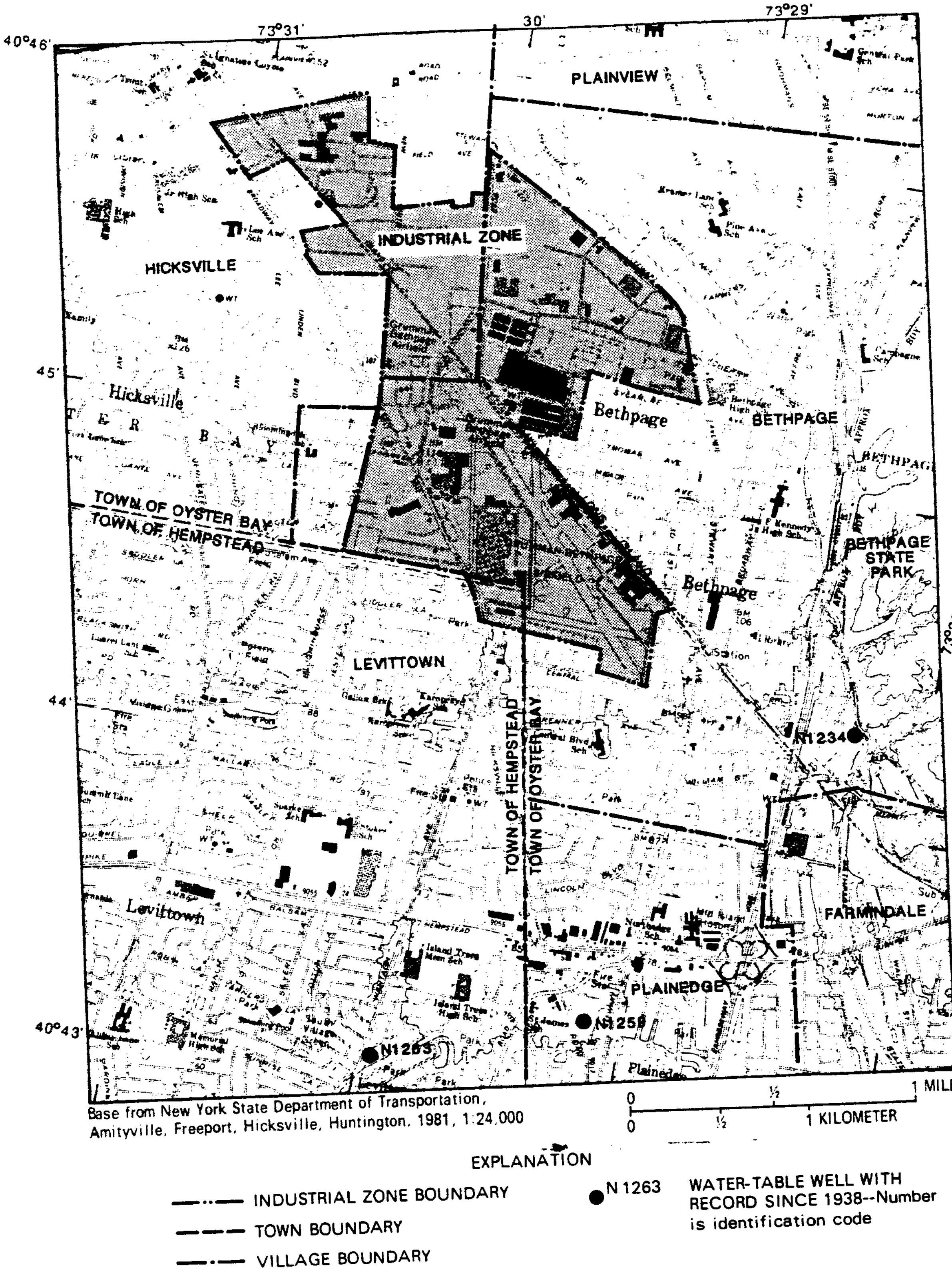


Figure 2.--Town and village boundaries and location of industrial zone in study area.

HKR 001 1817

The Bethpage-Hicksville-Levittown area is typical of Nassau County in that it is highly developed; it contains residential housing, commercial and industrial development, transporation corridors, and parks (fig. 2).

Most of the area is used for housing; commercial establishments occupy much of the land adjacent to the major roadways. Bethpage State Park (in the far eastern part of the area; see fig. 2) contains the only undeveloped area. Much of the northern half of the area is zoned industrial/commercial (fig. 2), and most of this area is occupied by an aerospace manufacturing firm. The facilities include large office buildings, recreational playing fields, various manufacturing or industrial buildings, storage areas and warehouses, and an airstrip.

The U.S. Geological Survey and the Nassau County Department of Health began a cooperative program in October 1985 to determine the geologic framework and ground-water conditions and movement in the study area.

Purpose and Scope

This report describes the geohydrologic units and ground-water levels in the upper glacial aquifer and underlying Magothy aquifer in the area of investigation. It includes maps of the water table in April and August 1986, the potentiometric surface of the Magothy aquifer in April 1986, structure-contour maps of the hydrogeologic units, and three hydrogeologic sections. It also includes graphs of pumpage, precipitation, and ground-water levels, and describes local water use.

Acknowledgments

Thanks are extended to Mark Shemet of the Nassau County Department of Health for his help in the water-quality sampling and test-well drilling programs.

GEOHYDROLOGY

Stratigraphy

Long Island is underlain by unconsolidated deposits of clay, silt, sand, and gravel that overlie southward-sloping consolidated bedrock. In Nassau County, these deposits are thinnest in the northwest part of the county (about 200 ft) and attain a maximum thickness of about 1,800 ft on the barrier islands in the southeastern part. The unconsolidated deposits range in age from early Cretaceous through Pleistocene; some recent deposits are present near shores and streams. The geologic units in Nassau County are differentiated primarily by age, method of deposition, and lithology. Hydrogeologic units are differentiated by their water-transmitting properties (table 1). In many areas the hydrogeologic units closely correspond to the geologic units.

Records of wells drilled over the past 60 years in the Bethpage-Hicksville-Levittown area are available. Many of the older wells have been abandoned or sealed, but the hydrogeologic information gathered from them

Table 1.--Hydrogeologic units and their water-bearing properties in the Bethpage-Hicksville-Levittown area, Nassau County, N.Y.

[Modified from Smolensky and others, in press]

System	Series	Geologic unit		Hydro-geologic unit	Approximate maximum thickness (ft)	Character of deposits	Water-bearing properties
Quaternary	Holocene	Recent deposits and fill		Recent deposits	10	Sand, gravel, clay, silt, organic mud, loam, and fill.	Constitutes soil zone and fill areas and is hydraulically connected to underlying upper glacial aquifer.
Quaternary	Pleistocene	Upper Pleistocene deposits		Upper glacial aquifer	75	Sand, fine to coarse, gravel, glacial outwash deposits, commonly brown or tan but may be yellow or orange. Some thin local lenses of clay or silty zones.	Outwash deposits are moderately to highly permeable. Average horizontal hydraulic conductivity is approximately 270 ft/d; anisotropy is approximately 10:1.
		unconformity					
Cretaceous	Upper Cretaceous	Magothy Formation-Matawan Group, undifferentiated		Magothy aquifer	650	Sand, fine to medium, clayey in part; interbedded with lenses and layers of coarse sand and sandy and solid clay. Gravel is common in basal zone. Sand and gravel are quartzose. Lignite, pyrite, and iron oxide concretions are common. Colors are gray, white, red, brown, and yellow.	Most layers are poorly to moderately permeable; some are highly permeable locally. Water is unconfined in uppermost parts, elsewhere confined. Principal aquifer for public supply. Average horizontal hydraulic conductivity is 50 ft/d; anisotropy is approximately 100:1.
		unconformity					
Cretaceous	Upper Cretaceous	Raritan Formation	Unnamed clay member	Raritan confining unit	175	Clay, solid and silty; few lenses and layers of sand. Lignite and pyrite are common. Colors are gray, red, and white, commonly variegated.	Low to very low permeability; constitutes confining layer above Lloyd aquifer. Average vertical hydraulic conductivity is approximately 0.001 ft/d.
Cretaceous	Upper Cretaceous	Raritan Formation	Lloyd Sand Member	Lloyd aquifer	300	Sand, fine to coarse, and gravel, commonly with clayey matrix; some lenses and layers of solid and silty clay; locally contains thin lignite layers. Sand and most of gravel are quartzose. Colors are yellow, gray, and white; clay is red locally.	Permeability low to moderate. Water is confined by overlying Raritan clay. Average horizontal hydraulic conductivity is 40 ft/d; anisotropy is approximately 10:1.
		unconformity					
Paleozoic and Precambrian	---	Bedrock		Bedrock	--	Crystalline metamorphic and (or) igneous rocks; muscovite-biotite schist, gneiss, and granite. Contains a soft, clayey weathered zone more than 50 ft thick locally.	Poorly permeable to relatively impermeable; lower boundary of ground-water system. Some hard fresh water is contained in joints and fractures but is impractical to develop at most places.

HKR 001 1819

remains useful. These records, used in conjunction with hydrogeologic maps (Smolensky and others, in press) and records from wells drilled recently by the Geological Survey, were used to define the geometry of the hydrogeologic system in the area.

Bedrock

The altitude of the bedrock surface in the Bethpage-Hicksville-Levittown area was inferred from an islandwide bedrock-configuration map by Smolensky and others (in press), which is based on data from wells that penetrate the bedrock at several points near the study area (fig. 3).

The bedrock is probably of Precambrian and Paleozoic age and consists primarily of schist and gneiss with igneous intrusions. Its southward-sloping surface is defined as a peneplain (Suter and others, 1949). It is relatively impermeable and therefore is considered to be the lower boundary of the ground-water system. Well cuttings and cores taken from boreholes that contacted bedrock elsewhere in Nassau County commonly indicate an upper zone of weathered bedrock up to a few tens of feet thick. This weathered zone, which is clayey with many decomposing rock fragments, probably extends beneath the Bethpage-Hicksville-Levittown area.

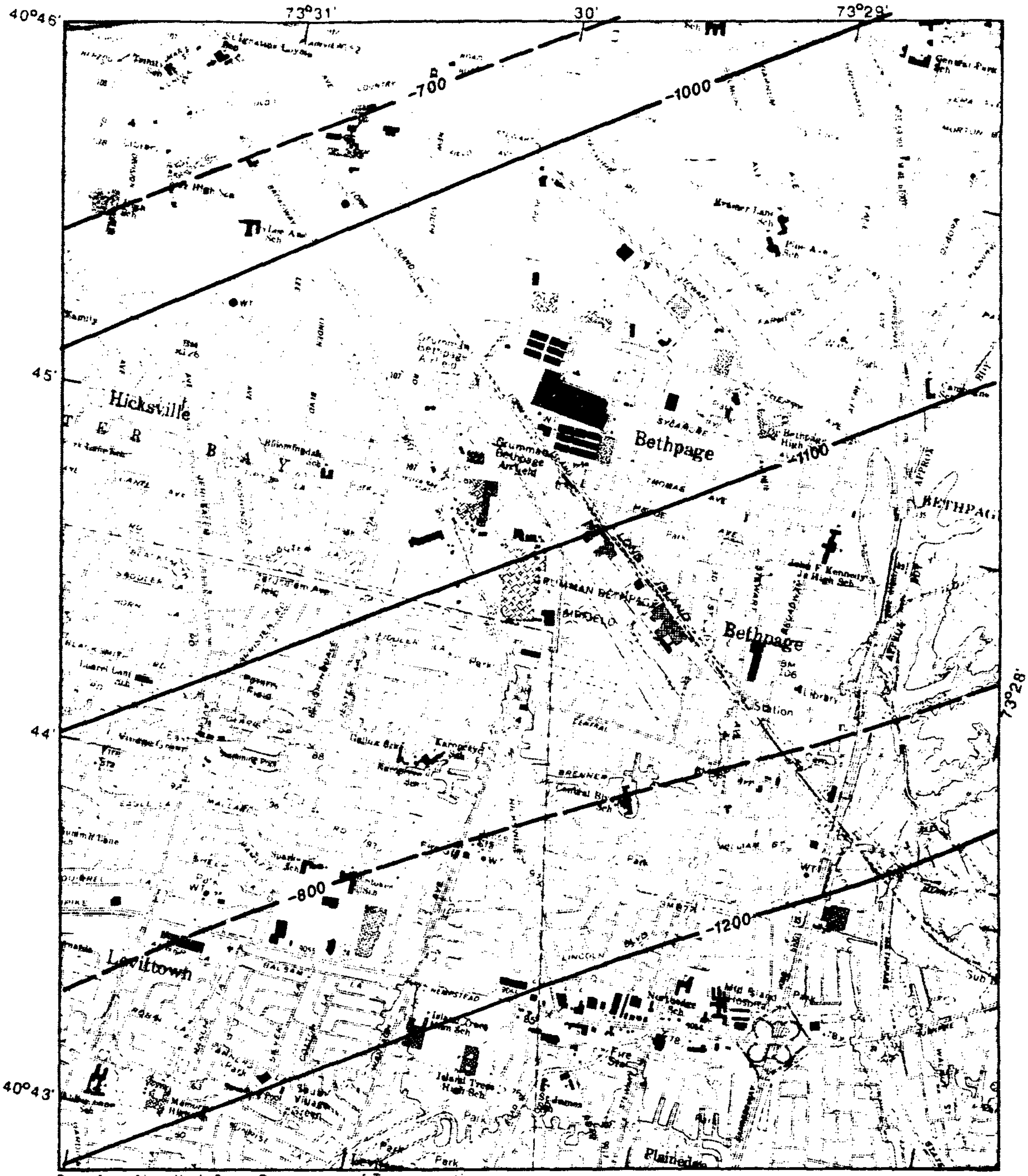
Cretaceous Deposits

Overlying bedrock is a sequence of Cretaceous sands, silts, gravels, and clays. These sediments are of terrestrial origin and probably were deposited by prograding shores and coalescing deltas. No deposits that are older than Cretaceous are seen in the geologic record in Nassau County. Whether pre-Cretaceous deposition never occurred or was removed by erosion is uncertain.

Raritan Formation.--Unconformably overlying the bedrock surface is the Raritan Formation, which is divided into the lower Lloyd Sand Member (Lloyd aquifer) and an overlying unnamed clay member (Raritan confining unit). No wells in the Bethpage-Hicksville-Levittown area penetrate the Lloyd aquifer, but its surface is inferred from islandwide maps to slope gently southward from approximately 680 ft (feet) to 840 ft below sea level in the northwestern and southeastern parts of the study area, respectively (fig. 3) (Smolensky and others, in press). The Lloyd aquifer is approximately 300 ft thick and gradually thickens southeastward. It consists primarily of sand and has moderate water-transmitting properties, but has not been used as a producing aquifer in this part of Nassau County.

Conformably overlying the Lloyd Sand Member is the unnamed clay member of the Raritan Formation (Raritan confining unit), which consists of clay and silt and sandy clay with a few thin zones of fine sand. The clay member may be red, gray, yellow, or white.

The top surface of the clay member (confining unit) has approximately the same southeastward dip as the Lloyd sand. Altitudes of the top of the unit range from less than 500 ft to about 650 ft below sea level in the northwestern and southeastern corners of the study area, respectively (fig. 4).



Base from New York State Department of Transportation,
Amityville, Freeport, Hicksville, Huntington, 1981, 1:24,000

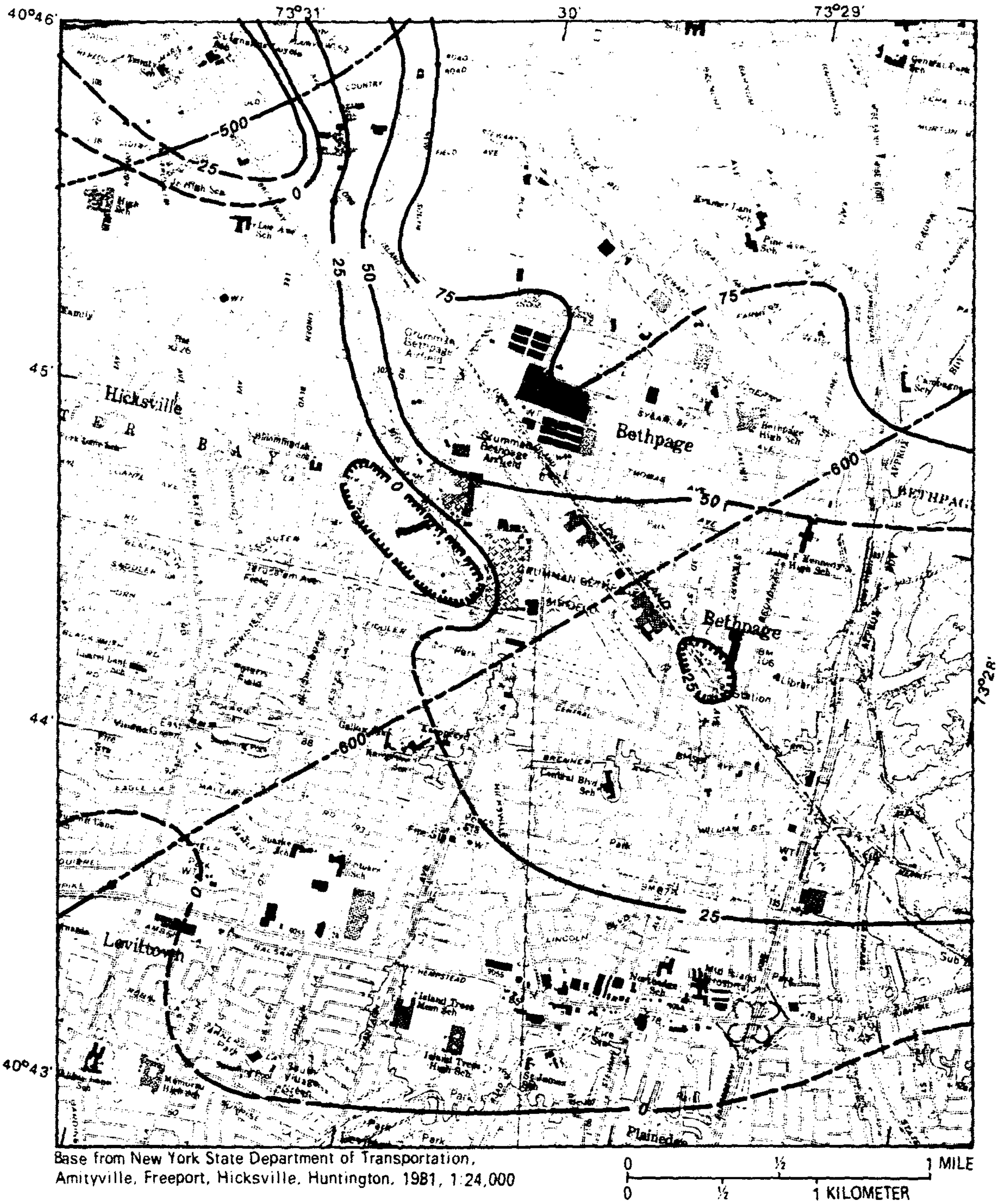
0 ½ 1 MILE
0 ½ 1 KILOMETER

EXPLANATION

—— -1200 —— STRUCTURE CONTOUR--Shows altitude of top of bedrock. Contour interval 100 feet. Datum is sea level

— — -800 — — STRUCTURE CONTOUR--Shows altitude of top of Lloyd aquifer. Contour interval 100 feet. Datum is sea level

Figure 3.--Inferred altitude of tops of bedrock and of the Lloyd aquifer of the Raritan Formation in Bethpage-Hicksville-Levittown area. (Modified from Smolensky and others, in press.)



EXPLANATION

-600 STRUCTURE CONTOUR--Shows altitude of top of Raritan confining unit. Contour interval 100 feet. Datum is sea level

25 STRUCTURE CONTOUR--Shows altitude of top of Magothy aquifer. Contour interval 25 feet. Hachures indicate depression. Datum is sea level

Figure 4.--Inferred altitude of tops of the Raritan confining unit of the Raritan Formation (dashed line) and the Magothy aquifer of the Magothy Formation-Matawan Group, undifferentiated.

HKR 001 1822

The lateral continuity of the clay within this unit severely retards vertical ground-water movement. Vertical hydraulic conductivity has been estimated to be about 0.001 ft/d (foot per day) (Franke and Cohen, 1972). The low conductivity of this unit, which averages 175 ft thick, helps in part to maintain the head difference between the underlying Lloyd and the overlying Magothy aquifer. Potentiometric-surface maps for March 1979 (Donaldson and Koszalka, 1983a, b) indicate this vertical head difference to be approximately 58 ft at the northern boundary of the Bethpage-Hicksville-Levittown area and gradually decreasing to about 35 ft at the southern boundary.

Magothy Formation-Matawan Group, undifferentiated.--The Magothy Formation-Matawan Group, undifferentiated (Magothy aquifer), is the youngest Cretaceous deposit in the Bethpage-Hicksville-Levittown area. A distinct unconformity separates its coarse basal zone from the underlying fine-grained clay member of the Raritan Formation.

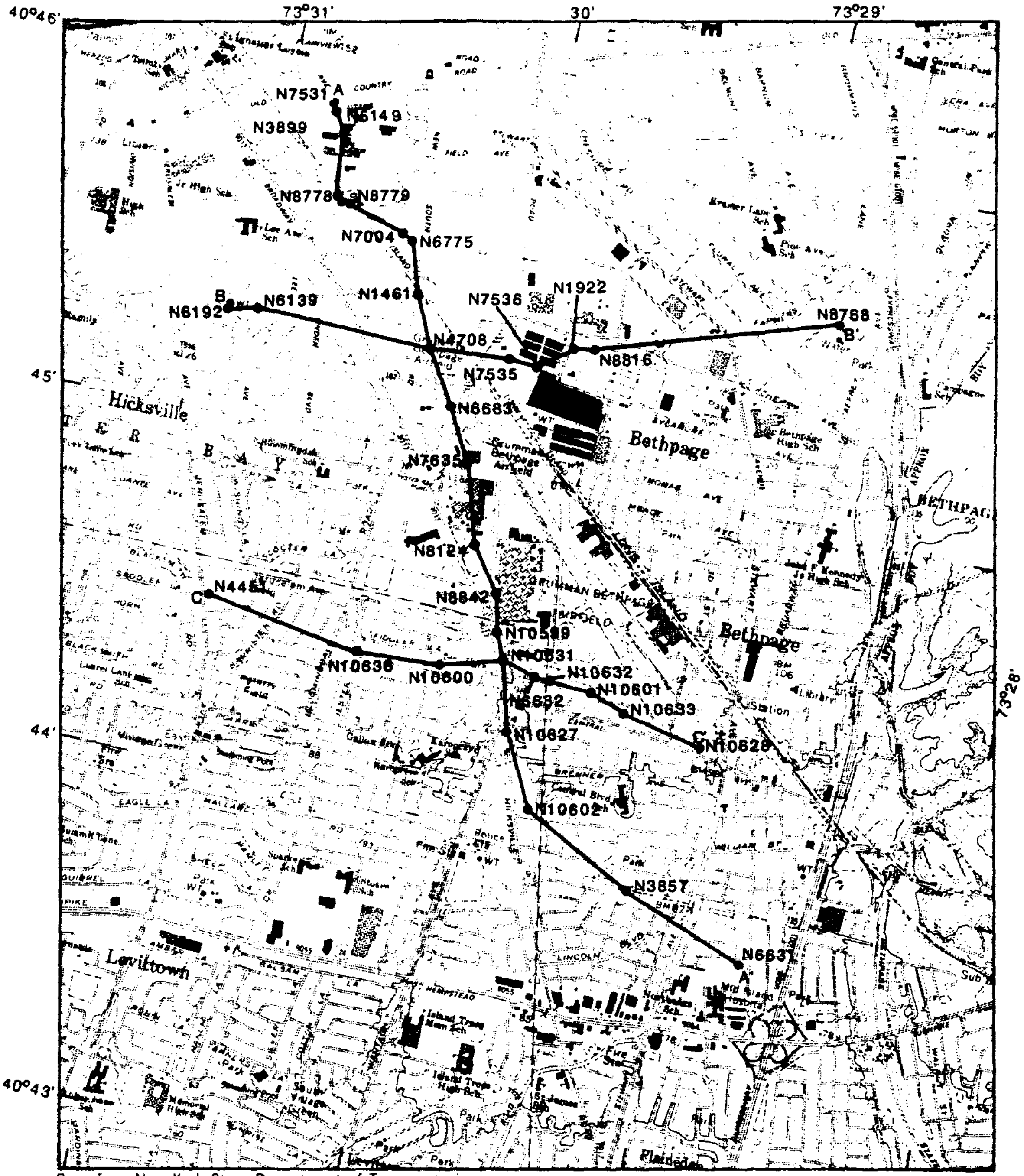
At least 110 wells have been drilled into the Magothy aquifer in the Bethpage-Hicksville-Levittown area. The well data and geologic correlations indicate the highest surface altitude of the Magothy aquifer in the area to be almost 100 ft above sea level (fig. 4) in the northeastern corner. The top of the Magothy slopes in two places, between the northeastern and northwestern corner of the study area to its lowest altitude of more than 25 ft below sea level; from the northwest corner to the southern boundary, it remains near or above sea level at altitudes of 0 to 25 ft above sea level. Maximum thickness is approximately 650 ft.

The Magothy aquifer consists of fine- to medium-grained, gray to white sand and clayey sand, although multicolored deposits are common. Geologists' logs from wells that penetrate the Magothy Formation also indicate zones of solid clay; geologic correlations show these zones to be discontinuous and of variable thickness (fig. 5, pl. 1). The clay lenses are only local but cause a high degree of anisotropy in the aquifer. Lignite is common and is abundant locally.

The upper surface of the Magothy was exposed to extensive erosion during the Pleistocene. Glacial scouring and shoving associated with direct ice contact probably occurred only in an area slightly north of the study area that coincides with the position of the glacial moraine, but the glaciofluvial erosion associated with episodes of advancing and retreating ice fronts had a marked effect on the entire surface configuration of the Magothy Formation within the study area (fig. 4). The estimated average horizontal hydraulic conductivity of the Magothy aquifer is 50 ft/d (feet per day), and anisotropy (ratio of horizontal to vertical hydraulic conductivity) is approximately 100:1 (Franke and Cohen, 1972).

Pleistocene Deposits

Overlying the Magothy aquifer are glacial deposits of Pleistocene age that form the upper glacial aquifer. Except where overlain by recent deposits (soil zone, streambed material), the glacial deposits extend to land surface throughout the Bethpage-Hicksville-Levittown area. These deposits are



Base from New York State Department of Transportation, Amityville, Freeport, Hicksville, Huntington, 1981, 1:24,000

0 ½ 1 MILE

0 ½ 1 KILOMETER

EXPLANATION

A●——●A TRACE OF HYDROGEOLOGIC SECTION

●N 4708 LOCATION OF WELL USED IN SECTION AND WELL IDENTIFICATION CODE

Figure 5.--Locations of hydrogeologic sections A-A', B-B', and C-C'. (Sections are shown on pl. 1.)

characterized as outwash and are a product of the Pleistocene ice advances, particularly the last advance during Wisconsin glaciation. The till and moraine deposits typically associated with glaciation occur only north of the study area. The deposition of the outwash and erosion of both Cretaceous and some earlier outwash during the Wisconsin was not a product of ice contact but rather glaciofluvial action (controlled by glacial meltwater).

The glacial deposits consist of medium-to-coarse sand and gravel. Some fine-grained sand and silt and local clay lenses also are present. Average horizontal hydraulic conductivity is approximately 270 ft/d, and anisotropy is approximately 10:1 (Franke and Cohen, 1972).

Ground Water

Water from precipitation infiltrates the land surface and percolates through the zone of aeration to the water table. The water table is the upper boundary of the system, and its fluctuations in altitude reflect changes in recharge to and discharge from the system.

Directions of Flow

Near the island's ground-water divide, which runs east-west along the north-central part of the island, water entering the system flows vertically downward, and then horizontally seaward (fig. 6).

Ground water flows along hydraulic gradients through and between aquifers and confining units. Ground water north of the divide eventually discharges into Long Island Sound, and ground water south of the divide discharges into Great South Bay and the Atlantic Ocean. These subsea-discharge areas, which flank the north and south shores of the island, form the lateral boundaries of the fresh ground-water system. Ground water also discharges from the system at stream channels that intersect the water table and at nearshore marshes and wetlands.

The movement, use, and disposal of water in the Bethpage-Hicksville-Levittown area is depicted as a flow diagram in figure 7 (p. 13). The period represented is the early 1980's (before sewering) except where noted as "after sewering," which represents the mid-1980's. To simplify the diagram, small losses and gains such as through leaky supply lines have been omitted.

The following three sections further explain the boundaries, recharge, and discharge from the ground-water system in the Bethpage-Hicksville-Levittown area as shown in figure 7.

Boundaries

The natural movement, flow patterns, and levels of ground water in the Bethpage-Hicksville-Levittown area are, in general, a reflection of those in the surrounding area. The location and size of the study area are such that

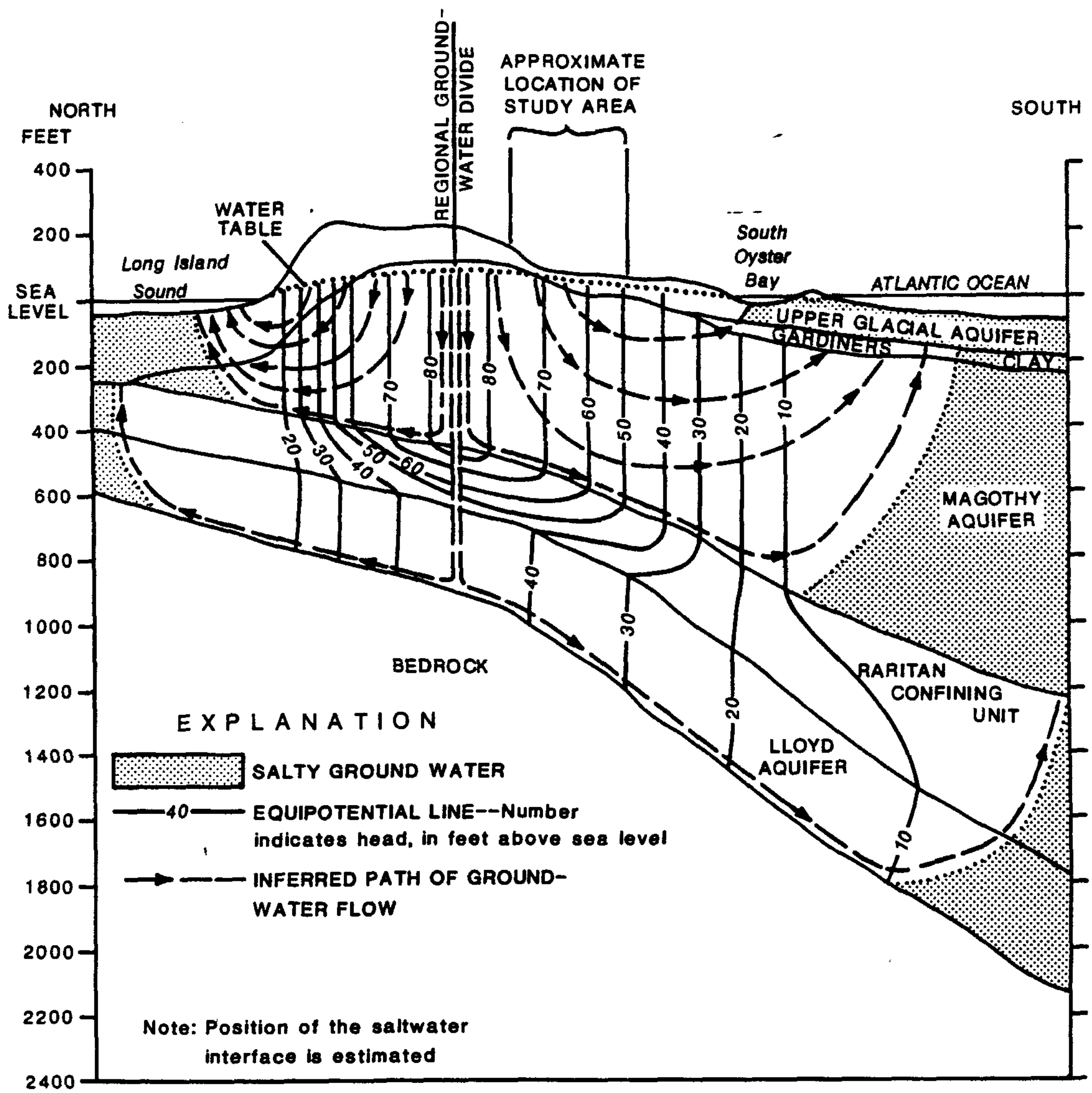


Figure 6.--Generalized north-south section through study area showing directions of ground-water flow. (Modified from Franke and Cohen, 1972.)

regional ground-water conditions strongly influence local conditions. The boundaries assigned in this local investigation do not represent true hydrologic-system boundaries but were selected to outline a part of the larger system. Thus, a regional ground-water stress, whether natural or man induced, that originates outside the study area has the potential to affect ground-water conditions within the study area.

In general, ground water in southeastern Nassau County flows from the island's ground-water divide southward toward the shore. The Bethpage-Hicksville-Levittown study area is part of this regional flow pattern. Approximately one-fifth of the ground water in the study area comes from the surrounding system, in which water flows along regional flow lines and gradients. At the northern boundary of the study area, ground water enters

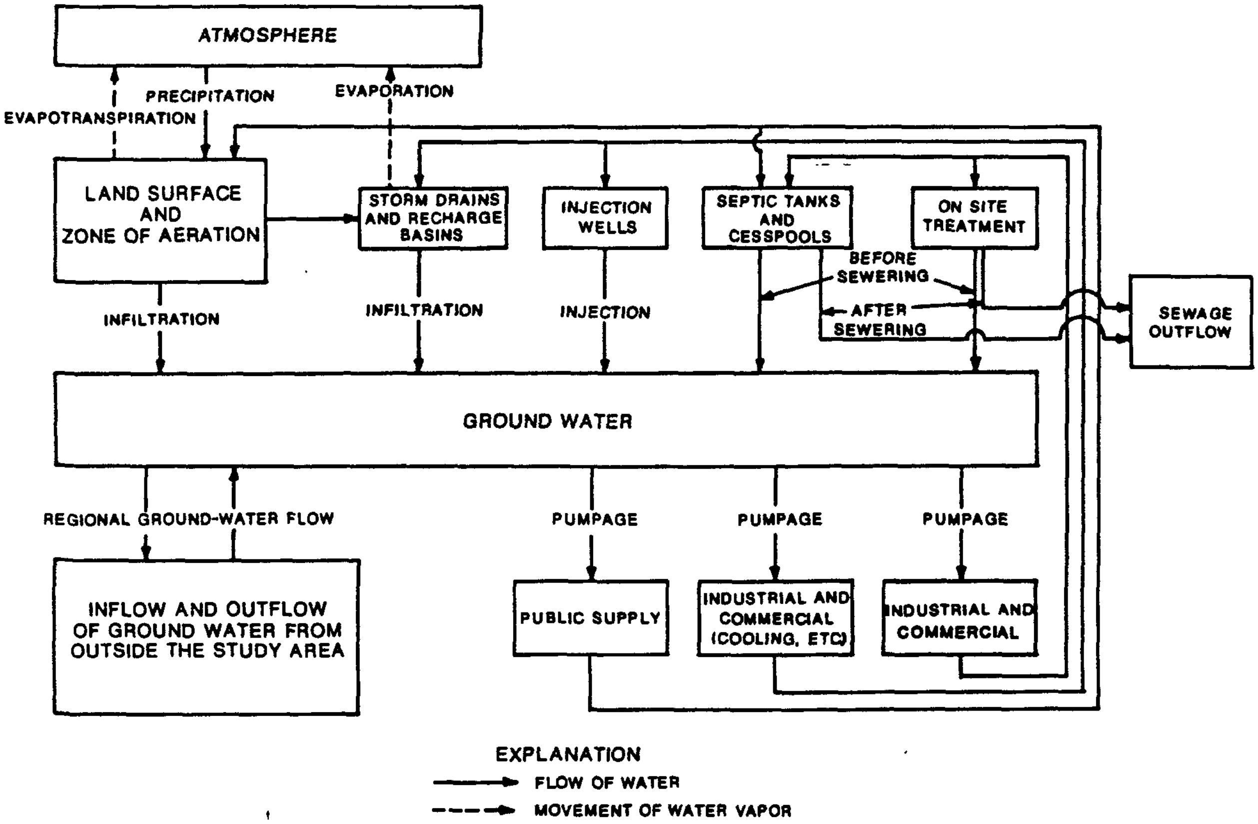


Figure 7.--Generalized flow diagram of water movement, use, and disposal in the Bethpage-Hicksville-Levittown area.

all three aquifers as part of the regional flow pattern. The quantity of water flowing into the study area across the northern boundary and out of the area across the southern boundary is determined by the hydraulic gradient and the water-transmitting properties and geometry of each aquifer.

The eastern and western boundaries may be both recharge or discharge boundaries. Hydraulic gradients across these boundaries are relatively small; therefore, fluctuations in recharge or in ground-water stresses could produce changes in both direction and (or) magnitude of these gradients. The quantity of water flowing across the eastern and western boundaries is substantially less than that at the northern and southern boundaries.

Recharge

Precipitation.--Precipitation is the only natural source of water that enters the ground-water system at land surface on Long Island. Under predevelopment conditions, about 50 percent of the precipitation percolated to the water table to become ground water; the rest either returned to the atmosphere through evapotranspiration or flowed to streams and from there to the sea. In developed areas, much of the overland flow is diverted through a system of storm drains to recharge basins from which it infiltrates to the ground-water system (fig. 7).

Mean annual precipitation in the Bethpage-Hicksville-Levittown area was 41.5 to 43 inches during 1951-65 (Miller and Frederick, 1969). More precipitation falls in the northern part of the study area than in the south. Precipitation falls in roughly the same amount during the cool season as during the warm season.

Records from three precipitation stations in and near the study area (fig. 1) reflect the seasonal and long-term precipitation patterns of the area. The record from the station at Hicksville (1959-77) is indicative of precipitation in the northern part of the area; that from Levittown (1968-73) represents patterns in the southern part. Data from the Mineola station, approximately 7 mi to the west (1939-86), although slightly higher than those in the study area, constitute the best available long-term record of the general precipitation regime. Annual precipitation at the three stations (1959-77) is plotted in figure 8A; that at Mineola in figure 8B.

The annual precipitation recorded at Mineola during 1939-86 ranged from 64.49 inches in 1983 to 23.67 inches in 1965 (fig. 8B). The long-term average annual precipitation for that period was 44.58 inches; 1962-66 were drought years, whereas the 1970's were fairly wet.

Cesspools and sewers.--Residential and commercial development in Nassau County was accompanied by the installation of thousands of onsite sewage-disposal systems; most large buildings and all homes were equipped with cesspool systems or septic tanks. Several industrial establishments had onsite treatment plants. These systems were considered to be a substantial source of recharge because they returned much of the water used for domestic purposes back into the aquifer system. They also discharged contaminants to the ground water, however, and thereby contributed to the overall degradation of water quality.

To curtail the degradation of water quality, Nassau County installed a sanitary sewer system that carries wastewater out of the study area to a centralized treatment plant. The system services both residential and commercial establishments. Since 1980, this sewer system has transported much of the pumped water that previously would have gone to cesspools to treatment plants, from which it is eventually discharged to the sea. Before sewering, 85 percent of the water pumped by the water districts was returned to the system through cesspools, but since completion of the sewer system, only about 20 percent is returned (H. T. Buxton, U.S. Geological Survey, written commun., 1986).

Recharge basins and injection wells.--The Bethpage-Hicksville-Levittown area makes extensive use of recharge basins. The basins differ greatly in size and capacity, but each is designed for only one of two purposes. The first is to dispose of stormwater runoff from residential and industrial areas and highways. The routing of storm runoff into recharge basins, where the runoff subsequently percolates to the ground-water system, is an alternative to the direct discharge of runoff to streams or tidewater, thereby avoiding a loss of recharge to the system. The study area contains about 80 such recharge basins.

The second type of basin is designed for the disposal of water used for cooling by local industry. This water is pumped from onsite, company-owned wells and, after being used at the facility, is routed to onsite basins where it infiltrates back into the ground-water system. Approximately 12 Mgal/d (million gallons per day) is returned to the aquifer system during summer from such basins.

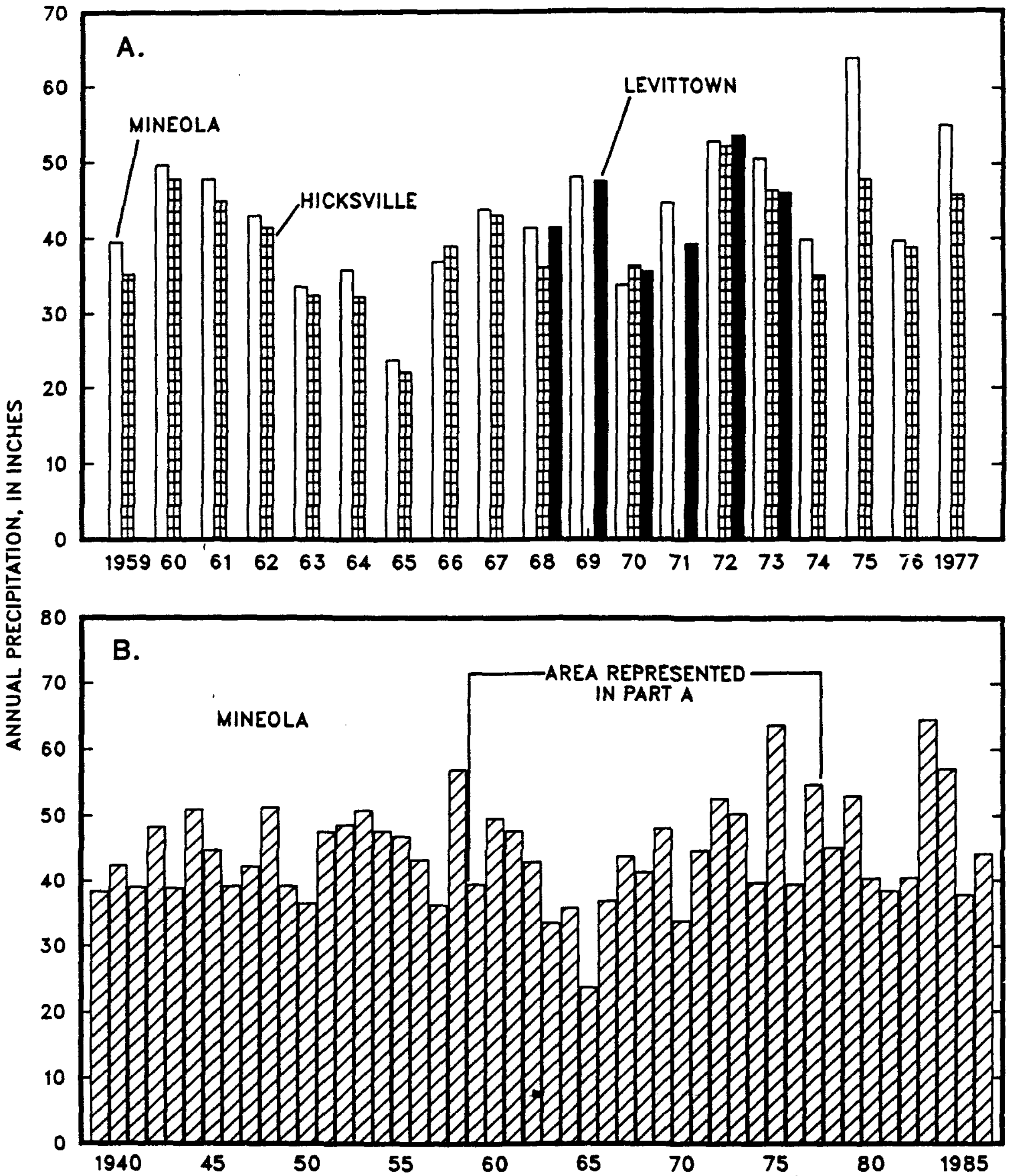


Figure 8.--Annual precipitation: A. At Mineola, Hicksville, and Levittown, 1959-77. B. At Mineola, 1939-86. (Location of stations shown in fig. 1).

HKR 001 1829

Several commercial establishments in the area use an alternative method to dispose of cooling water. After the water pumped from onsite wells is used, it is injected into the aquifer at approximately the same depth from which it was originally removed. Because little water is lost in this process, this type of water use and disposal has little effect on flow patterns or water budgets.

Discharge

Ground water in the Bethpage-Hicksville-Levittown area is used for industrial processes as well as for public supply. Industrial wells obtain water from both the upper glacial aquifer and the underlying Magothy aquifer; public-supply water is derived solely from the Magothy aquifer. No wells in the Bethpage-Hicksville-Levittown area pump water from the Lloyd aquifer.

Public-supply withdrawals.--Public-supply withdrawals for the residential areas are controlled by the local water districts. Most industries in the area use public-supply water for drinking and other domestic purposes, even though many have their own wells. Before public-supply water enters the distribution system, it must meet all water-quality standards set forth by governing agencies.

In 1985, public-supply wells in the study area pumped a total of 10.2 Mgal/d of ground water. The Hicksville and Bethpage Water Districts accounted for about 74 percent of that total, the Town of Hempstead Department of Water accounted for 20 percent, and the Plainview Water District, in the northeast corner of the study area, accounted for the remaining 6 percent.

The Bethpage-Hicksville-Levittown area has experienced increased development along with the rest of Nassau County, and this trend has been accompanied by an increased water demand. During 1980-85, the combined pumpage of these four water districts increased over that of the previous 5-year period, and each individual water district reflects this trend (fig. 9). These plots do not reflect an increase in total pumpage for each water district, but only for district-owned wells that are within or are close to the study area. Public-supply pumpage is highest during summer months (fig. 10).

Another cause for concern is the gradual deterioration of ground-water quality in the upper part of the Magothy aquifer, which has resulted in the shutdown of several wells. Since 1966, seven public-supply wells have been abandoned. Six of these pumped water that had nitrate concentrations above allowable levels of 10 milligrams per liter of NO_3 as N, and one well was restricted because it had trichloroethylene (TCE) in concentrations that intermittently exceeded the New York State guideline of 50 micrograms per liter. These wells range in depth from 84 to 386 ft. The 18 wells that currently are in use range in depth from 256 to 770 ft and have an average depth of 564 ft.

Industrial supply withdrawals.--The only large industrial pumpage in the Bethpage-Hicksville-Levittown area at present is at the aerospace manufacturing firm, where 14 wells pumped a total of 7.6 Mgal/d in 1985 for cooling purposes. This pumpage has been roughly constant since 1975. Other industrial users of ground water in the area have only a minor influence on the ground-water budget relative to the quantities pumped by the water districts and the aerospace firm.

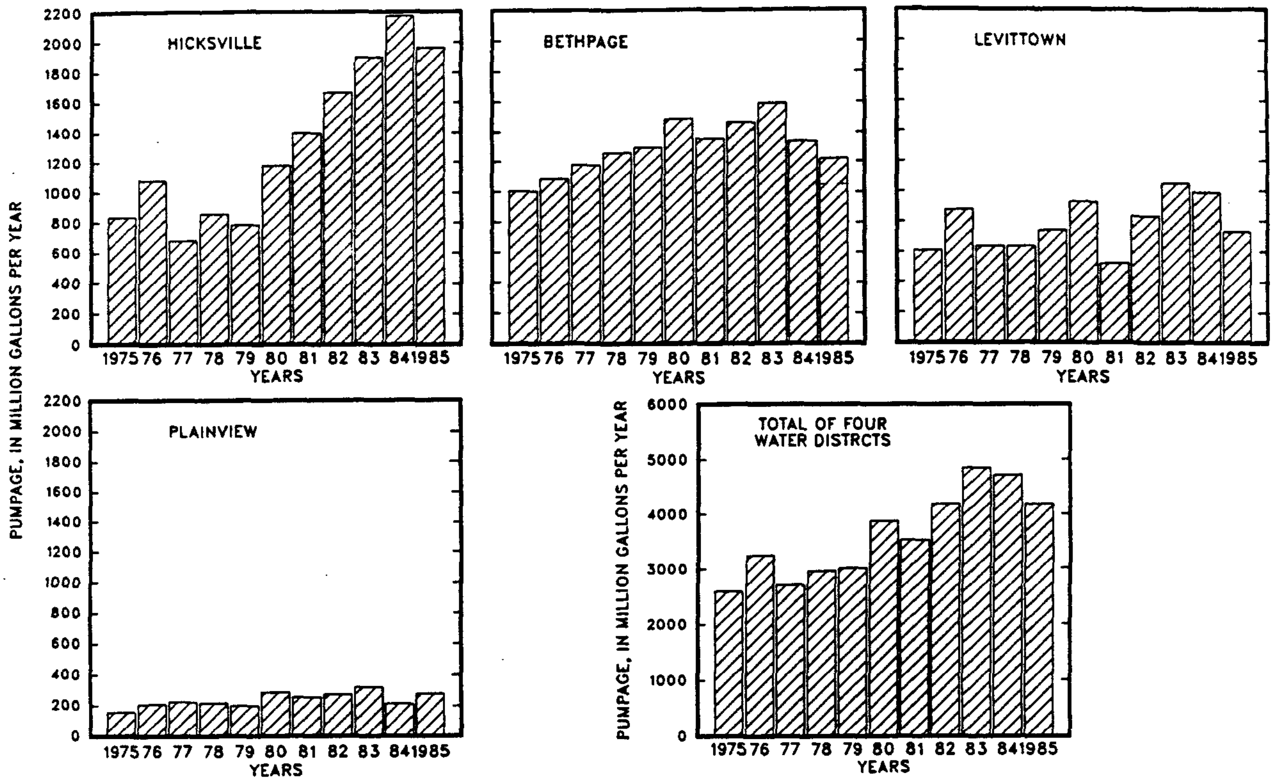


Figure 9.--Annual pumpage for public supply by the four water districts and their combined annual totals, 1975-85.

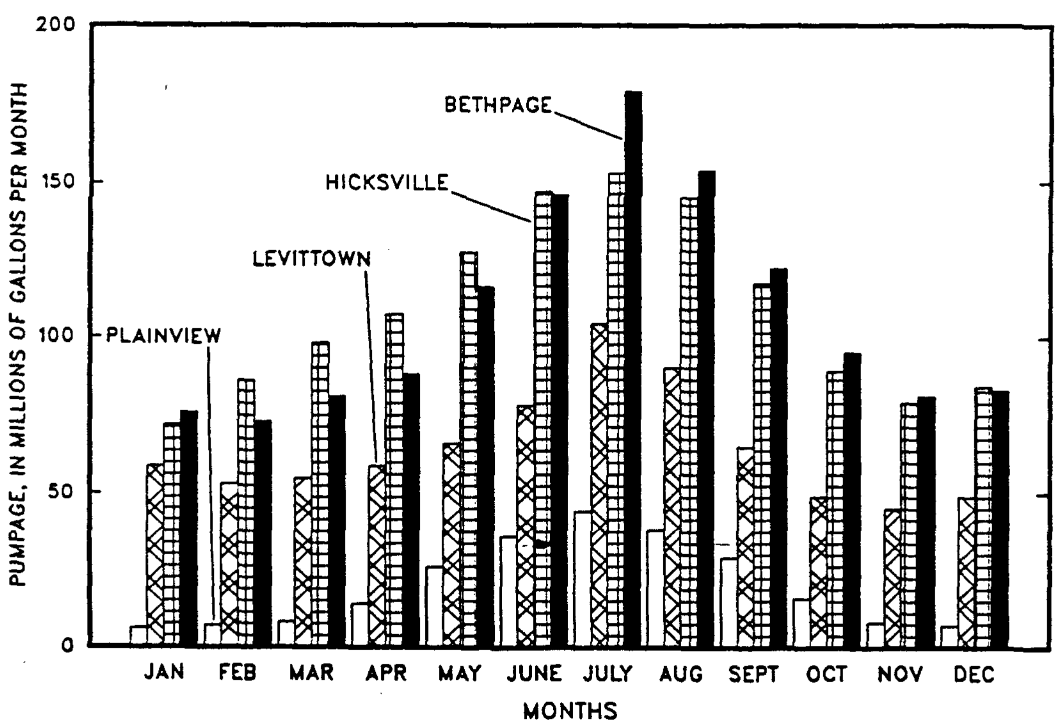


Figure 10.--Average monthly pumpage from the four water districts, 1975-85.

HKR 001 1831

Water Levels

Water levels in the upper glacial and Magothy aquifers in the Bethpage-Hicksville-Levittown area reflect the short and long-term effects of both natural and man-induced stresses on the ground-water system. Water levels in wells screened near the top of the saturated deposits indicate the altitude of the water table at the well location.

Continuous water-level records have been collected at three water-table wells, N1263, N1259, and N1234 (fig. 2) since 1938 (fig. 11). The seasonal and long-term changes in water levels reflect several factors. Water levels are high during the cool season, when evapotranspiration is minimal and recharge from precipitation is greatest (Miller and Frederick, 1969), and are low during the growing season, when evapotranspiration is greatest.

As the demand for water increases during the warm season, local water companies increase their public-supply pumpage. Monthly pumpage is normally at its maximum in July, then is reduced gradually into the winter (fig. 10). This pumping stress, together with the natural decline in recharge during the growing season, are the two main causes of the seasonal fluctuation of water levels. Long-term fluctuations result from several years of above-normal or below-normal recharge; for example, a long-term decline in water levels during 1961-67 is evident from the hydrographs in figure 11; this reflects the prolonged drought that affected the northeastern United States at that time. In contrast, the late 1970's were a relatively wet period, as evidenced by higher water levels.

High and low annual precipitation during 1978-86, combined with the effects of additional sewer hookups and increased pumpage, have made each factor's influence on water levels difficult to isolate. Except for an increase in water levels in 1983 and 1984, which coincided with unusually high precipitation, water levels declined from 1978 through 1986. This 9-year period was one of approximately average precipitation. The increase in pumpage may partially explain this decline.

In the fall of 1986, water levels in the southern part of the study area declined to their lowest recorded levels to date, even below the drought levels of 1965-66 (fig. 11, wells 1263 and 1259). A possible explanation for this trend is the decrease in the amount of water reentering the system from disposal systems as these are abandoned in favor of sewer hookups. If annual amounts of precipitation remain close to the long-term average, and if pumpage remains constant, water levels throughout the area can be expected to decrease slowly in response to the reduced recharge rates that result from the diversion of wastewater to sanitary sewers. The decrease would continue until new equilibrium conditions are reached or stresses placed on the ground-water system change.

Water table in April 1986.--Water levels measured at 20 wells screened in the water-table aquifer in April 1986 ranged from 78.86 to 47.19 ft above sea level in the northern and southern parts of the study area, respectively. These measurements were used to plot the configuration of the water table shown in figure 12. Equipotential lines are oriented east-west, which indicates that ground-water flow in the upper glacial aquifer in this area is primarily southward, as is regional flow from the ground-water divide to the southern shore.

Estimates of regional horizontal hydraulic conductivity (270 ft/d) and porosity (0.3) of the upper glacial aquifer were used to calculate regional horizontal ground-water velocities. A north-south gradient of 33 ft of head per 20,000 ft across the study area yields a velocity of 1.5 ft/d. This velocity is only an approximation, though, because it assumes that the hydraulic gradient is constant across the area, and does not account for local hydrogeologic variations or stresses such as pumping and recharge.

The water-table configuration in the Bethpage-Hicksville-Levittown area may be affected by several factors:

1. Small mounds in the water table probably have formed beneath recharge basins at the aerospace facility. Although no measurements have been made to confirm their presence, several recharge basins are used almost continuously. The inferred mounding is indicated in figure 12.

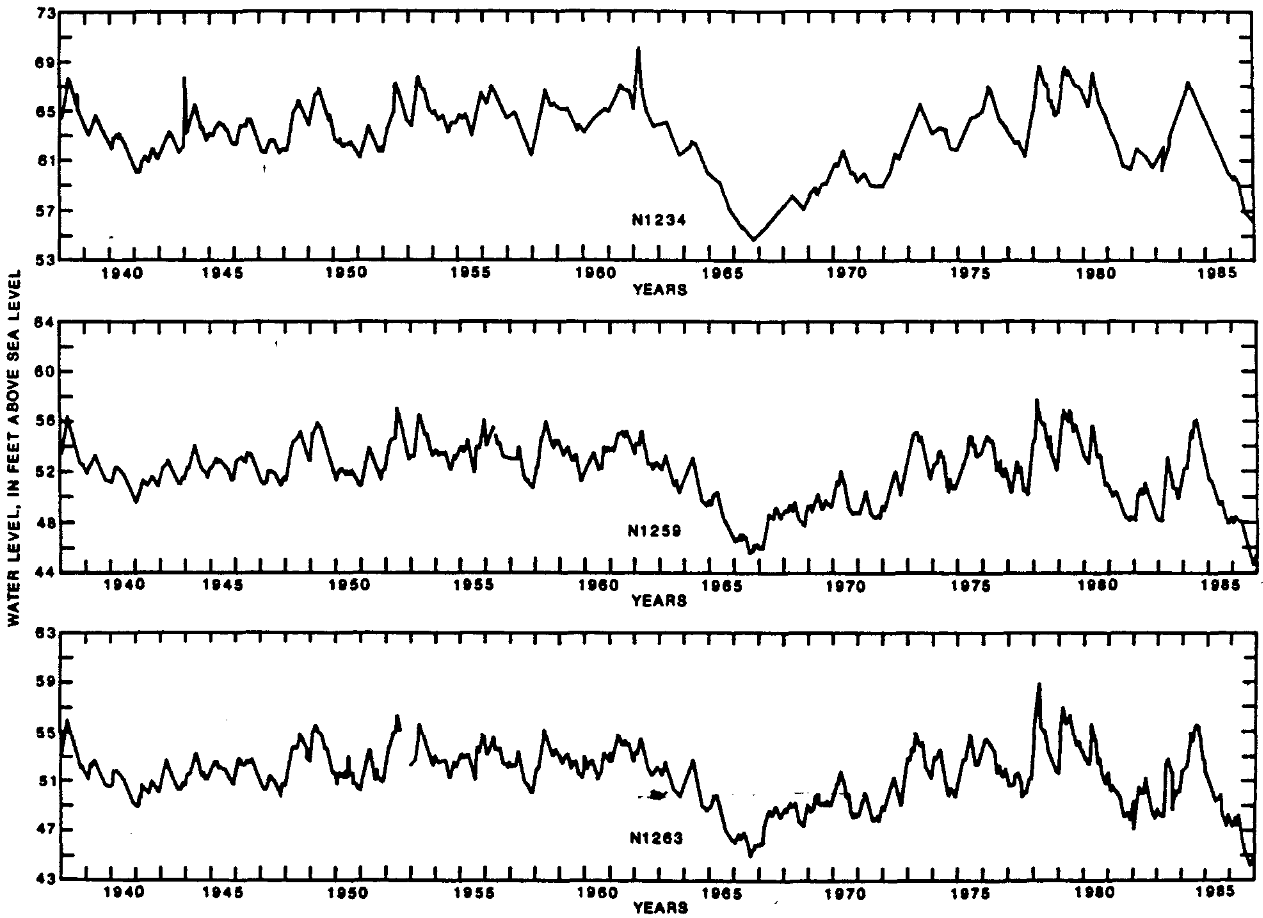
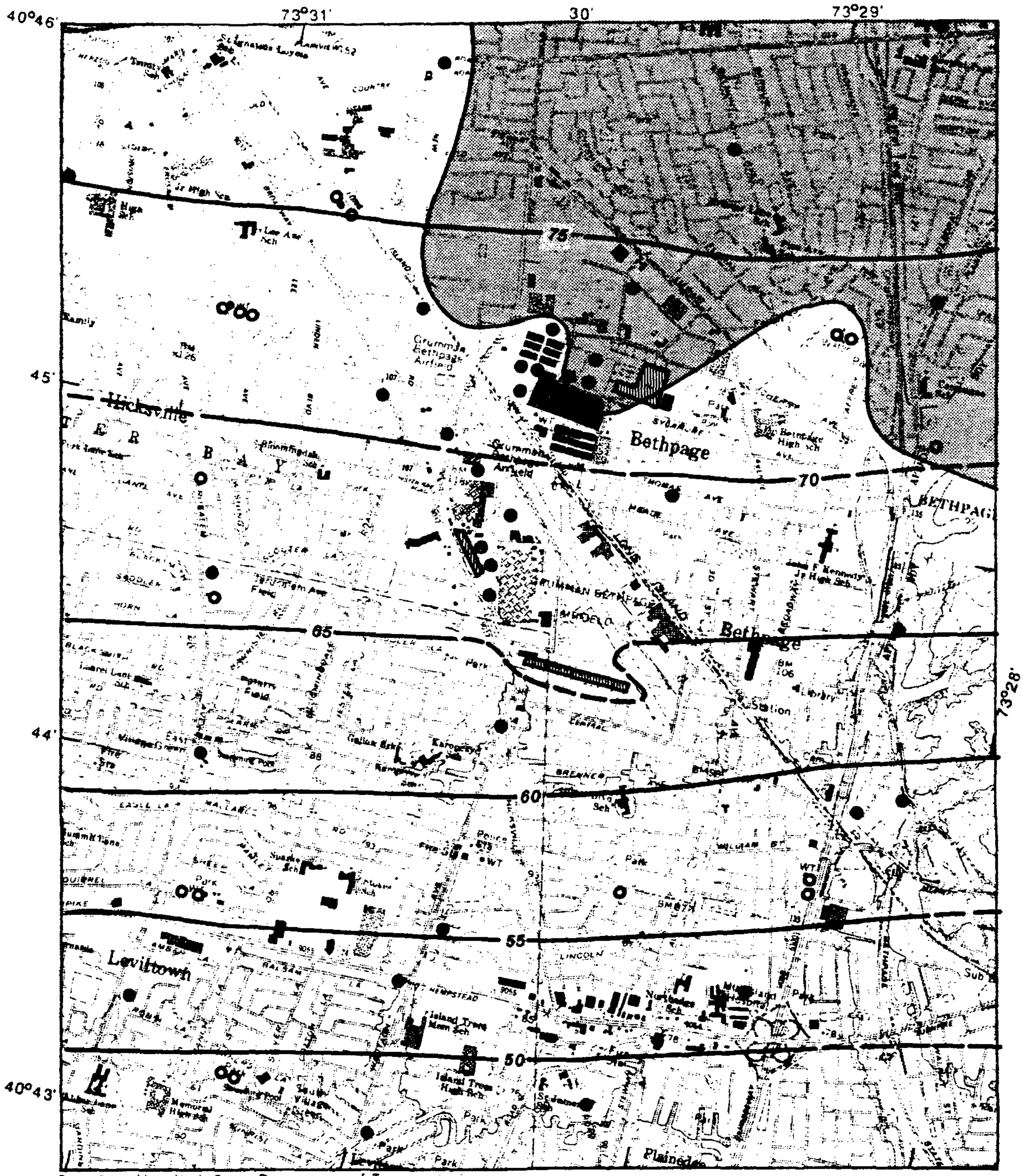


Figure 11.--Water levels in wells N1234, N1259, and N1263, during 1938-86. (Well locations are shown in fig. 2).



Base from New York State Department of Transportation,
Amityville, Freeport, Hicksville, Huntington, 1981, 1:24,000

0 ½ 1 MILE
0 ½ 1 KILOMETER

EXPLANATION

ACTIVE INDUSTRIAL RECHARGE BASIN

APPROXIMATE AREA WHERE WATER TABLE IS WITHIN THE MAGOTHY AQUIFER

—— 60 —— WATER-TABLE CONTOUR--Shows altitude of water table. Contour interval is 5 feet. Dashed where approximately located. Datum is sea level

O PUBLIC-SUPPLY WELL

◉ INDUSTRIAL WELL

● OBSERVATION WELL SCREENED AT WATER TABLE

Figure 12.--Water-table altitude in the Bethpage-Hicksville-Levittown area, April 1986.

2. Wells that pump large volumes of water may cause local depressions in the water table. Although the water pumped by public-supply and major industrial wells is drawn from deep in the Magothy aquifer, this withdrawal may cause a drawdown in the overlying upper glacial aquifer. The inferred drawdowns at such wells are not indicated in figure 12, however, because specific information is lacking.

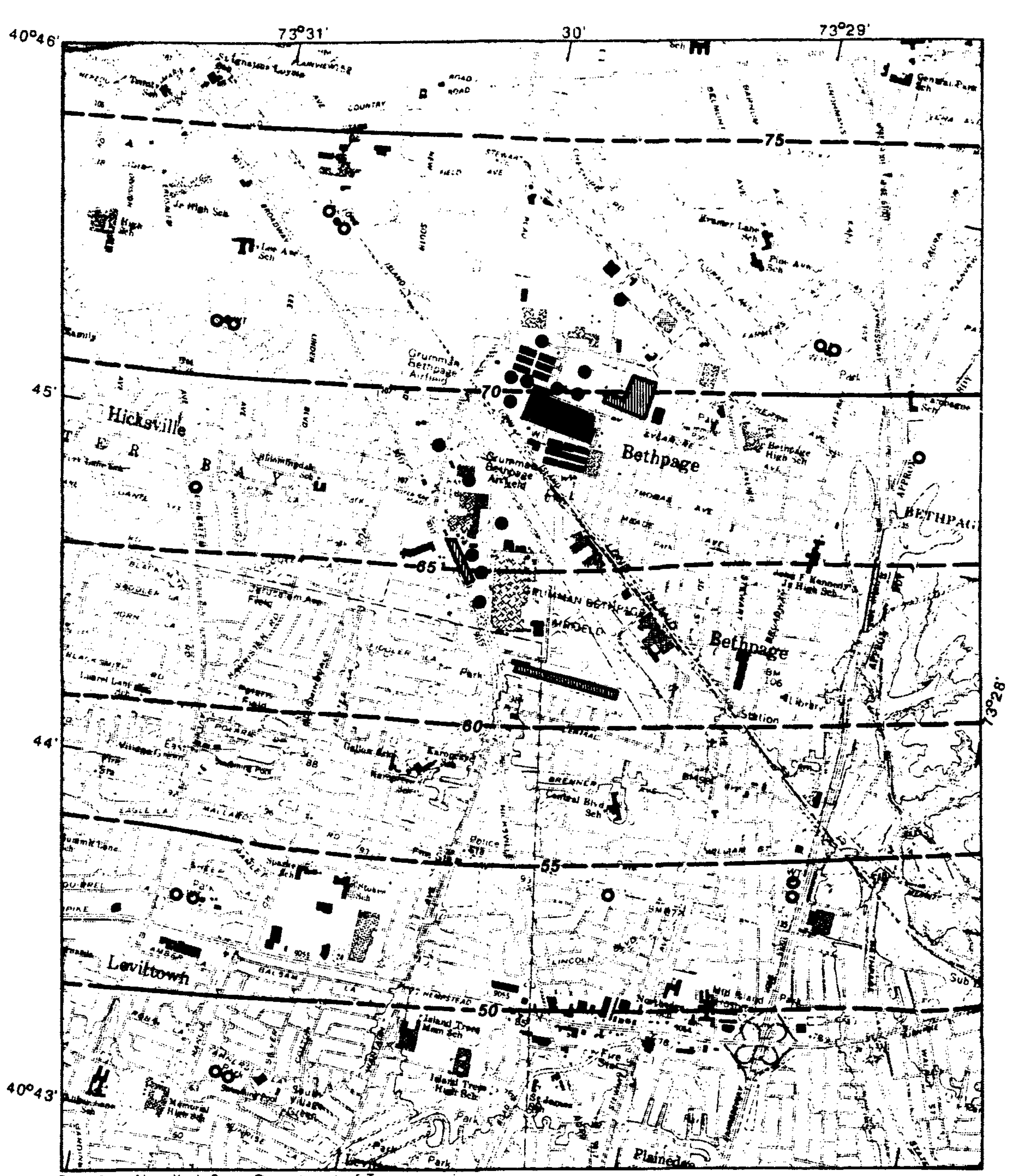
3. The type of material that makes up the water-table aquifer can affect the shape of the water table--that is, a local change in the hydraulic properties of the aquifer may be reflected in the configuration of the water table. For example, the upper surface of the Magothy aquifer is higher than the water table in the northeastern part of the study area, and the Pleistocene deposits are unsaturated; thus, the Magothy is the water-table aquifer in this area. Elsewhere in the study area the water table is in the upper glacial aquifer. The difference between horizontal hydraulic conductivity of the upper glacial aquifer (270 ft/d) and that of the Magothy aquifer (50 ft/d) probably affects the water-table configuration, but no data are available to verify this.

Potentiometric surface of the Magothy aquifer in April 1986.--The configuration of the potentiometric surface of the Magothy aquifer (fig. 13) is similar to that of the water table. Water levels measured at 15 public-supply wells screened in the lower half of the Magothy aquifer ranged from 75.4 to 47.1 ft above sea level in the northern and southern parts of the study area, respectively. Two additional wells beyond the northern boundary were measured but are not shown in figure 13. Accurate water-level measurements were difficult to obtain from these wells because many of them had been pumped just before the measurements were made and (or) are part of a well field in which nearby wells are being pumped.

Comparison of the water-table map (fig. 12) with the potentiometric-surface map (fig. 13) indicates a small vertical head gradient toward the Magothy aquifer.

Water table in August 1986.--In the summer of 1986, 20 additional observation wells were installed in the upper glacial aquifer to further delineate the water-table configuration in the study area. Comparison of April water levels (fig. 12) with those of August (fig. 14) indicates two major differences. The first is that the water table was 1.5 to 3 ft lower in August as a result of the seasonal loss of recharge and the increased pumpage at this time of year; this decline is within the range of fluctuation for an average annual cycle. The second difference is that water-table mounding at the aerospace facility was greater in August than in April. The demand for water for cooling and air conditioning at this facility is met by pumping water from depths between 360 and 570 ft below land surface (Magothy aquifer) and later discharging the water to recharge basins at land surface. Water levels near the basins in August were as much as 7 ft above the ambient level and may have been even higher at locations closer to the basins. Three basin groups are used for most of the recharge (fig. 14).

Water pumped from the Magothy aquifer at the aerospace facility is discharged onsite; thus, pumpage volumes are representative of recharge volumes less small amounts used onsite and evaporation at basins. Average monthly pumpage (and thus recharge) for 1968-85 has been greatest in August (fig. 15).



Base from New York State Department of Transportation,
Amityville, Freeport, Hicksville, Huntington, 1981, 1:24,000

0 ½ 1 MILE
0 ½ 1 KILOMETER

EXPLANATION

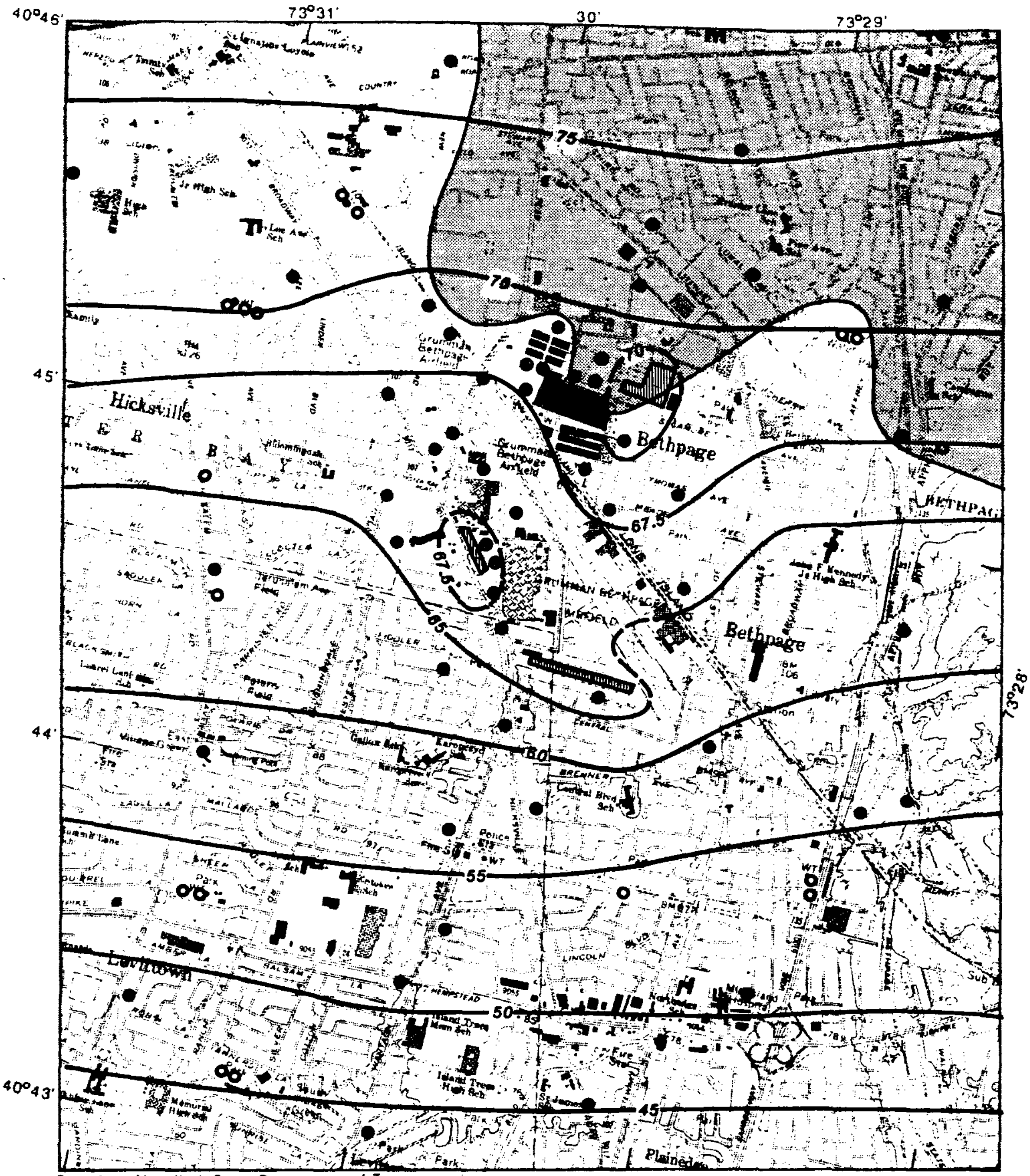
ACTIVE INDUSTRIAL RECHARGE BASIN

—— 50 —— POTENTIOMETRIC-SURFACE CONTOUR--Shows altitude of potentiometric surface. Dashed where approximately located. Contour interval is 5 feet. Datum is sea level

O ---- PUBLIC-SUPPLY WELL USED FOR WATER LEVEL MEASUREMENT

⦿ INDUSTRIAL WELL

Figure 13.--Potentiometric-surface altitude of the Magothy aquifer in the Bethpage-Hicksville-Levittown area, April 1986.



Base from New York State Department of Transportation,
Amityville, Freeport, Hicksville, Huntington, 1981, 1:24,000

0 ½ 1 MILE
0 ½ 1 KILOMETER

EXPLANATION

ACTIVE INDUSTRIAL RECHARGE BASIN

APPROXIMATE AREA WHERE WATER TABLE IS WITHIN THE MAGOTHY AQUIFER

—45— WATER-TABLE CONTOUR--Shows altitude of water table. Contour interval is 5 feet. Dashed where approximately located. Datum is sea level

O PUBLIC-SUPPLY WELL

◎ INDUSTRIAL WELL

● OBSERVATION WELL SCREENED AT WATER TABLE

Figure 14.--Water-table altitude in the Bethpage-Hicksville-Levittown area in August 1986.

The highest mounding should occur during periods of large withdrawals. The practice of pumping at depth in virtually the same location as the recharge site has a substantial effect on three-dimensional flow patterns. Under natural conditions, the vertical gradient between the water table and the basal Magothy is 1 to 4 ft. The hydraulic conductivity and anisotropy of the aquifers would indicate the vertical movement of water to be relatively slow. Deep pumping and surface recharge decrease the hydraulic head at depth, however, and increase the head at the water table, which greatly increases the vertical gradient and the rate of vertical ground-water flow.

The horizontal hydraulic gradient near the recharge mounds also is affected. The horizontal velocity of ground water is greatest near the point of recharge and decreases toward the edges of the mound.

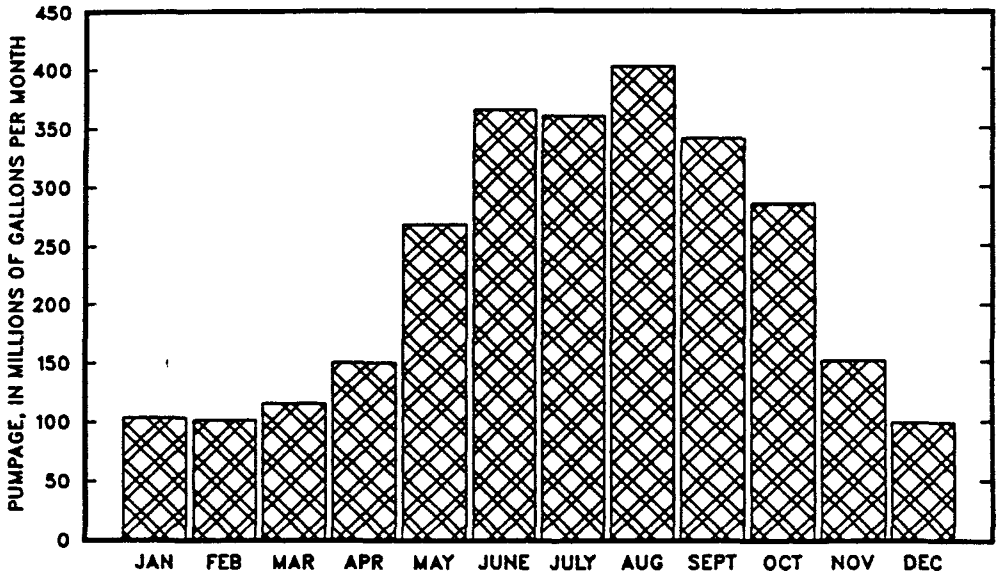


Figure 15.--Average monthly pumpage of aerospace facility wells, 1968-85. (Data from New York State Department of Environmental Conservation. Location shown in figs. 12, 13, and 14.)

SUMMARY AND CONCLUSIONS

The Bethpage-Hicksville-Levittown area is in a highly developed urban-residential and industrial-commercial part of east-central Nassau County. The demand for water by industrial and residential users places a major stress on the ground-water system. Aquifers are the only source of water for these users, and proper management of the resource requires extensive data on water levels, aquifer properties, and flow patterns in the area.

The area is underlain by four hydrogeologic units that are, in descending order, the upper glacial aquifer, Magothy aquifer, Raritan confining unit, and the Lloyd aquifer. The Lloyd aquifer has not been used as a water supply, and the upper glacial aquifer, which has become contaminated, is pumped only for minor industrial use. All of the public-supply water and most of the water used by industry is pumped from the Magothy aquifer.

The Magothy aquifer represents about half the total thickness (1,200 ft) of the four hydrogeologic units. The Magothy and upper glacial aquifers both have good water-transmitting properties but contain many clay lenses that produce a high degree of anisotropy and locally may inhibit vertical flow.

The water table slopes southward with a relatively constant gradient across most of the area. Water levels fluctuate as much as 3 ft seasonally between April and August. Industrial recharge basins, used extensively during summer, produce ground-water mounding at the water table. Industrial pumping at depth in the vicinity of the recharge basins creates large local changes in the vertical hydraulic gradient.

REFERENCES CITED

Donaldson, C. D., and Koszalka, E. J., 1983a, Potentiometric surface of the Magothy aquifer, Long Island, New York, in March 1979: U.S. Geological Survey Open-File Report 82-160, 2 sheets, 1:125,000.

_____1983b, Potentiometric surface of the Lloyd aquifer, Long Island, New York, in January 1979: U.S. Geological Survey Open-File Report 82-162, 2 sheets, 1:125,000.

Franke, O. L., and Cohen, Philip, 1972, Regional rates of ground-water movement on Long Island, New York: U.S. Geological Survey Professional Paper 800-C, p. C271-C277.

Miller, J. F., and Frederick, R. H., 1969, The precipitation regime of Long Island, New York: U.S. Geological Survey Professional Paper 627-A, 21 p.

Smolensky, D. A., Buxton, H. T., and Shernoff, P. K., Hydrogeologic framework of Long Island, New York: U.S. Geological Survey Hydrologic Investigations Atlas HA-709, 3 sheets, 1:250,000 (in press).

Suter, Russell, deLaguna, Wallace, and Perlmutter, N. M., 1949, Mapping of geologic formations and aquifers of Long Island, New York: New York State Water Power and Control Commission Bulletin GW-18, 212 p.

☆ U.S. GOVERNMENT PRINTING OFFICE:713-216

Prepared in cooperation with the
NASSAU COUNTY DEPARTMENT OF HEALTH

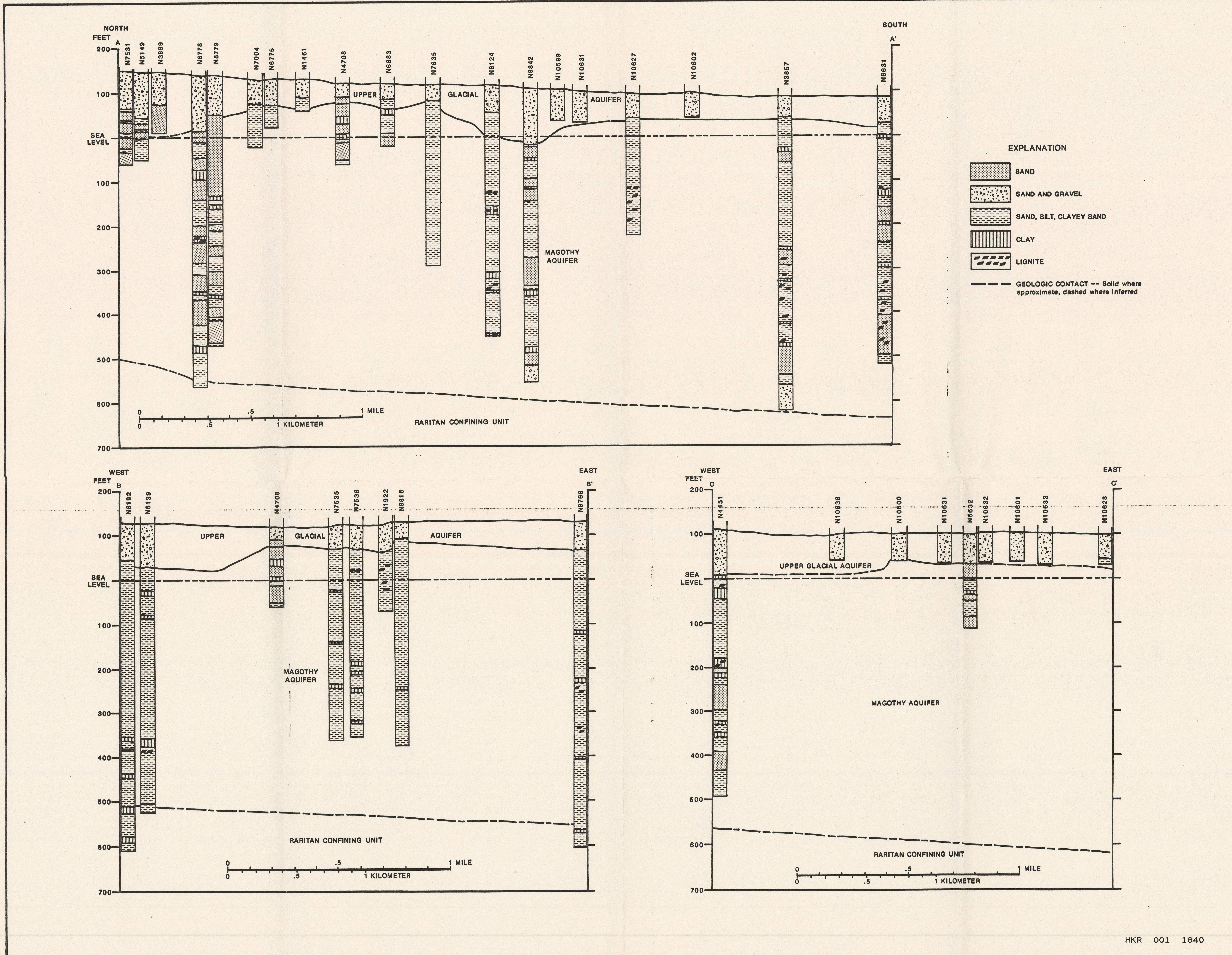


PLATE 1.—HYDROGEOLOGIC SECTIONS A–A', B–B', AND C–C' IN THE BETHPAGE–HICKSVILLE–LEVITTOWN AREA, LONG ISLAND, NEW YORK (LOCATIONS ARE SHOWN IN FIGURE 5)